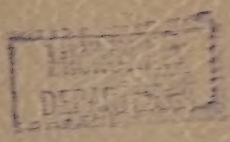


H-103591

MICROWAVE AMPLIFIER
MODEL 526

Serial No. 32

ALAN E. HOLLEY

ALFRED ELECTRONICS

Stanford Industrial Park Palo Alto, California

H-103591

MICROWAVE AMPLIFIER
MODEL 526

Serial No. 32

ALAN E. HOLLEY

Calibration Engr. BH Date 2/20/62

ALFRED ELECTRONICS 897 COMMERCIAL STREET, PALO ALTO, CALIF.

ADDENDUM SHEET

Model 526, 527, 528

Change No.	Effective S/N	Description
10856	14, 16, 17, 19 & up	C-10, 0.5 μf, 600 v, deleted from solenoid supply C-10, 150 μf, 150 v, added across L-2

MICROWAVE AMPLIFIER
MODELS 526, 527, 528

SPECIFICATIONS

	526	527		528
Frequency Range:	12.4 to 18 Gc	8 to 12.4 Gc	8 to 11 Gc	7 to 11 Gc
Power Output:	1 watt into 50 Ω load	2 watts into 50 Ω load	5 watts into 50 Ω load	5 watts into 50 Ω load
Gain (at rated power output):	30 db minimum	27 db minimum	27 db minimum	30 db minimum

Gain (small signal @ 200 mw output):	30 db minimum
Gain Adjustment:	0 to 10 db gain reduction at 200 mw by adjustment of front panel ANODE voltage control from maximum to minimum.
Modulation:	Greater than 30 db gain variation by 300 volt external pulse.
Spurious Modulation:	At least 40 db below output signal level.
RF Impedance:	50 Ω - 527, 528
RF Connectors:	Type N female receptacle, 527, 528 541 U choke flange - 526
Metering:	Helix current, and Collector current on 4" front panel meter, selected by front panel switch. Helix and cathode tip jacks available at rear for checking with external precision voltmeter.
Front Panel Controls:	ANODE voltage (maximum to minimum setting). HELIX voltage (3000 to 3500 volts). METER current switch.
Power Supply:	All TW tube electrode voltages, and solenoid current are regulated. Protective relay shuts off TW tube power upon helix overcurrent.
Input Voltage:	105 to 125 volts, 50 - 60 cps, approximately 1200 VA
Physical:	Bench with perforated metal dust cover. Handle sides are removable to permit mounting in standard 19" rack. Height: 12 1/4" Width: 19" Depth: 16" from panel, 17 ½" overall.
Finish:	Panel, grey hammertone Sides, top and bottom, dark metallic grey.
Weight:	100 pounds

SECTION 1 - GENERAL

1-1 DESCRIPTION

The ALFRED Models 526, 527, 528 Microwave Amplifiers are stable, high gain, broadband power amplifiers of microwave signals in the frequency range of 7.0 to 18 Gc. They are compact, versatile instruments consisting of a traveling wave tube, its focusing solenoid, and a power supply for all required operating voltages. Electrical protection is provided to prevent damage to supply or TW tube from misadjustment or failures. Thus the varied and unique traveling wave tube characteristics may be conveniently applied to laboratory and systems use. Some possible applications are:

1. Power amplification of wide band signal generator outputs or complex modulated RF signals.

2. Amplification of RF pulses with rise times as short as a few millimicroseconds.

3. Isolation of a load from a microwave signal source.

4. Generation of extremely stable microwave oscillations either at fixed frequency or tunable over a wide range, using an external resonant feedback network.

On the front panel of the Models 526, 527, 528, provisions are made for either Type N or wave guide fittings for RF input and output. Also provided are controls for ANODE and HELIX voltages to optimize performance for specific applications. A panel meter may be selected by a switch to monitor either helix or collector current.

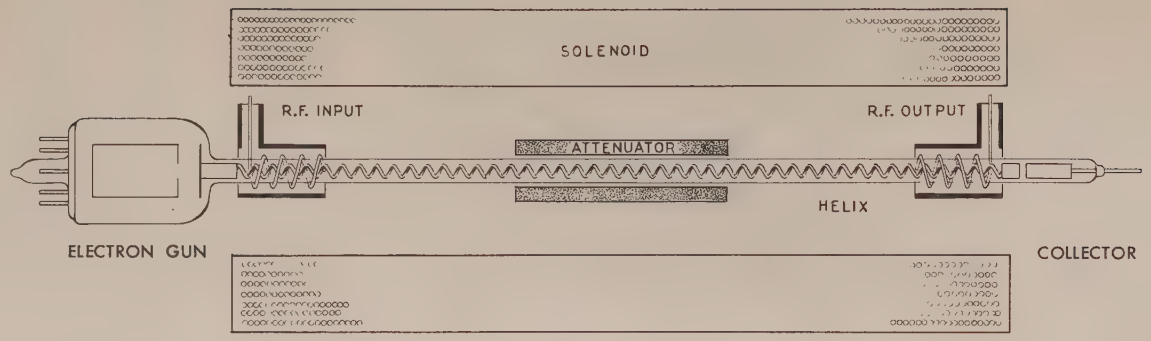
The TW tube requires no RF adjustment, is encapsulated for protection, and is easily replaced. The TW tube RF connectors may be mounted on the front panel or on the rear deck, or the RF connectors may be reversed in the field.

The Models 526, 527, 528 are built as convenient laboratory bench instruments. However, simply by removal of outside sheet metal sides, it may be mounted in a standard relay rack.

SECTION 2 - THEORY OF OPERATION

2-1 GENERAL DESCRIPTION OF TW TUBE

The traveling wave tube physical arrangement is indicated in Figure 1. The electron gun produces a beam of electrons which travels down the axis of the helical wire coil to the collector. The magnetic flux from the surrounding solenoid restricts the beam to travel axially along the tube just inside the helix. RF signals at low impedance are connected to the helix at the electron-gun end and travel down the metallic path of the helix. The velocity of the electron beam is critically adjusted by the potential



Schematic View of Traveling-Wave Tube

FIGURE 1

difference of the cathode and helix so that the beam velocity down the axis is just a little faster than the progressive RF signal on the helix. The field of the helix RF signal causes the electrons to bunch, so that at the collector end, their increased field returns to the helix an amplified signal which is conducted out to the load. Reflections down the helix are absorbed by the attenuator, consisting of a lossy helix externally placed and positioned between input and output. Due to the low impedance connections to the helix and the relatively long effective path provided by the TW tube, uniform amplification over a broad band of frequencies is achieved.

A more complete description and associated pertinent information are presented in the Engineering Notes, at the end of this manual.

2-2 TW TUBE PERFORMANCE CHARACTERISTICS

Gain and Power Output

Figure 2 Model 526, Figure 3 Model 527, Figure 4 Model 528 show typical curves of small signal gain, gain at rated output, and maximum power output as a function of frequency. These curves are taken at rated helix voltage. The small signal gain is better than 30 db over the frequency range. Gain at rated output is greater than 30 db over the same frequency range. Anode attenuation is greater than 10 db by panel control and grid attenuation is greater than 30 db by an external 300 volt pulse. Grid modulating pulse voltage must exceed 270 volts. Pulses of lower voltage will cause improper tube operation.

2-3 RF LOAD

The TW tube may be operated at any collector current up to rated value into a RF load with any voltage standing wave ratio in the rated frequency range. Performance will be stable without spurious oscillations, but output power will be less into mismatched loads.

2-4 POWER SUPPLY

1. An electronically regulated solenoid current source providing 5 amperes at approximately 75 volts.

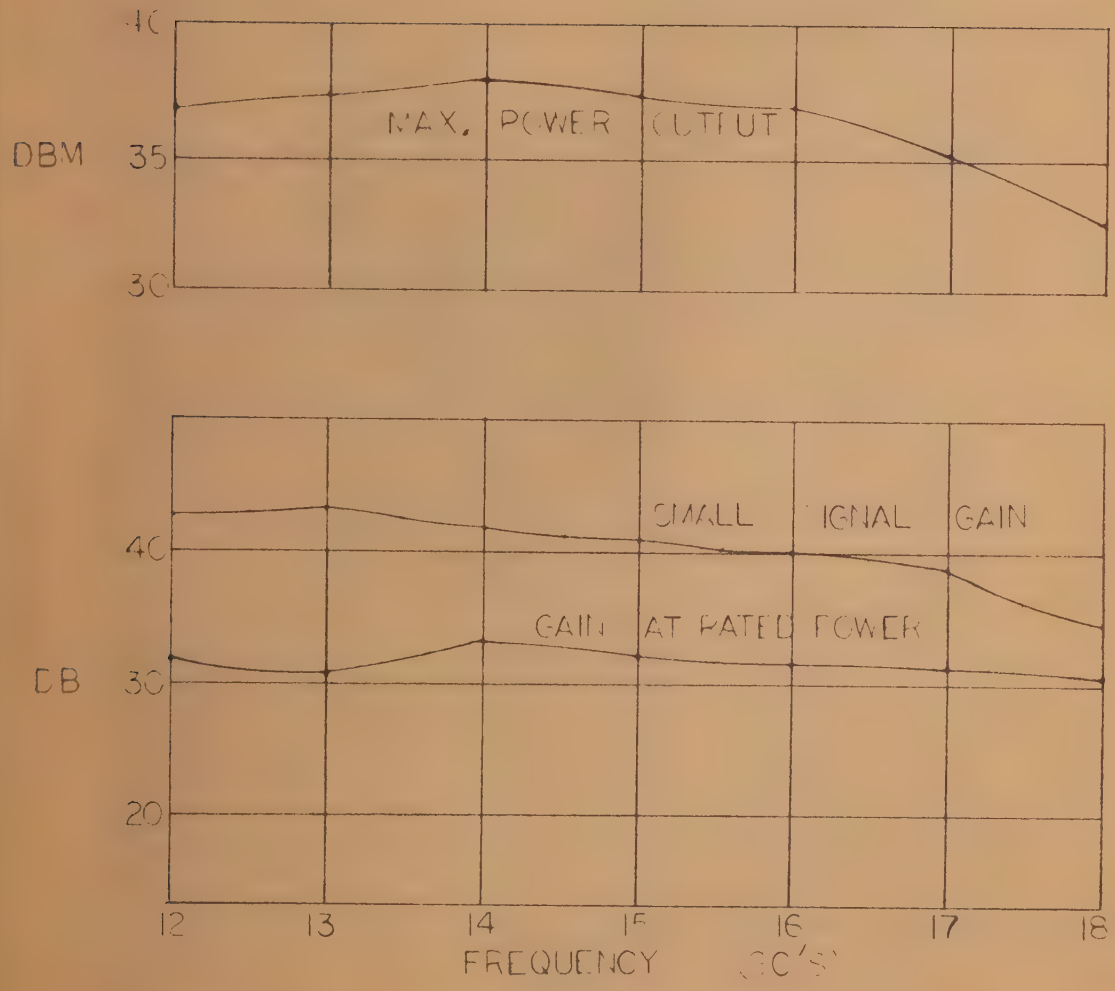
2. A transistor regulated AC heater supply for the TW tube providing 6.3 volts insulated for full cathode DC voltage.

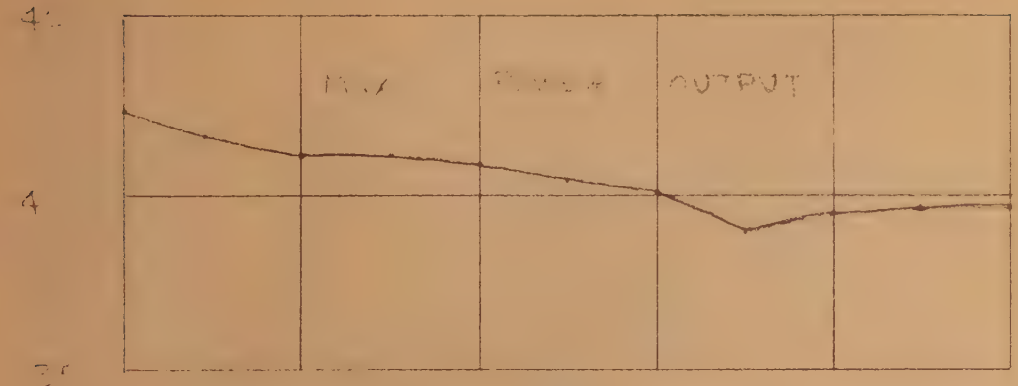
3. An electronically regulated Helix, Anode and Collector supply providing voltage from 2700 to 3500 volts with 300 mv peak to peak ripple or less.

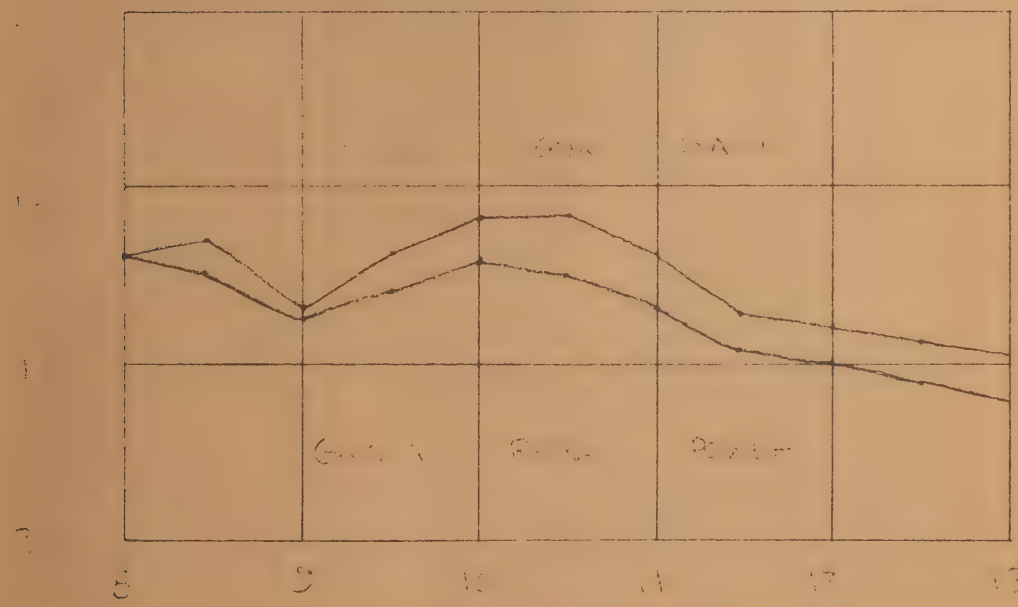
   An overcurrent relay causes shutoff of all high voltage should helix current exceed 3 ma for any reason.

2-5 FUNCTION OF CIRCUITRY

Function of circuitry - see schematic in back of manual.


40
DBM 35
30
MAX. POWER OUTPUT
SMALL SIGNAL GAIN
40
GAIN AT RATED POWER
DB 30
20
12
13
14
15
16
17
18
FREQUENCY (C/S)


OUTPUT



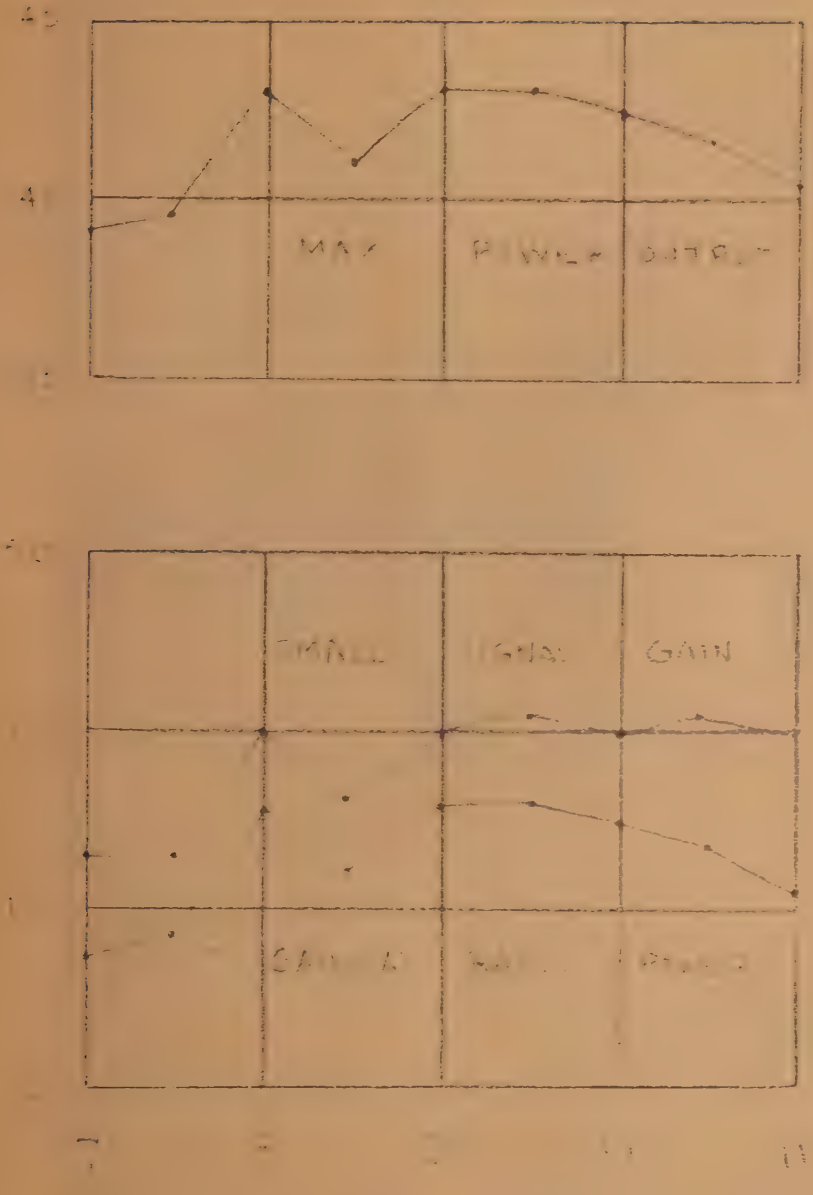


FIG 4

2-6 POWER AND SWITCHING

All power to the instrument is fed through POWER switch SW1 and the normally closed thermal switch located in solenoid L2. The thermal switch is set to open at approximately 200° F. When the power switch SW1 is closed transformers T1 and T3 are immediately energized through POWER fuse F2 to provide filament voltages to the -300 volt grid supply, the 56 volt screen supply, and the 200 volt supply required in the helix overcurrent relay RY2 circuit. Helix overcurrent relay RY2 picks up through tube V9. The high voltage circuit powered by transformer T2, through fuse F1 and contacts of relays RY1 and RY2 may be energized by depressing the "High Voltage On" switch SW3 to pick up relay RY1. Interlock contacts on RY1 maintain the circuit when SW3 is released. The H. V. supply may be de-energized by depressing H. V. OFF switch SW2 or should overcurrent relay RY2 drop out due to excessive helix current.

2-7 SOLENOID SUPPLY

Current regulated solenoid supply input power is applied to silicon rectifiers SR29 through SR32, through POWER switch SW1, SOLENOID fuse F3 and the normally closed Solenoid Thermal switch. Current from the rectifier is filtered by L1, C29 and C30. R101, 102 and 104 serve as a current sensing resistance developing a voltage which is compared with the reference voltage from ZD2. Any error developed in the comparison circuit is amplified by Q3 and applied to the base of the current control transistor Q2. R95-98, are current shunts to minimize the loading on Q2. Diode SR34 and R94 comprise a circuit to protect ZD2 from overloads at turnon. R104 "SOLENOID I CALIB" is used to compensate for circuit element tolerances. The regulated current is then fed to focusing solenoid L2. A normally closed thermal switch mounted in L2 opens if its temperature exceeds 200° F to remove DC power from solenoid. Excessive temperature may damage both TW tube and solenoid and could result from blower failure or abnormal ambient. Blower power is obtained through fuse F3. R105 calibrates 1 amp/volt test points.

2-8 LINE REGULATED SUPPLIES 6.3 V, 300 V, and 56 V

Regulation of these supplies is accomplished by regulating the input to the primary of transformer T3. Transistor Q1 is effectively in series with the input transformer T3. Rectifiers SR23 to 26 are connected in a bridge network to provide DC to the transistor for the positive and negative swings of the AC line. The drop across the transistor is automatically adjusted so the voltage to T3 will be maintained constant, independent of line voltage changes. The drop across the transistor is varied by employing Zener diode ZD1 as a stable reference through which output voltage change controls net transistor base current. On one half cycle forward transistor emitter to base bias is developed through 5 K resistor R88 and the low forward diode resistance of the Zener. On the other half cycle the bias current is opposed by any output voltage in excess of the Zener breakdown voltage and is developed through the low forward diode resistance of SR22. Biasing is set so that variation of ± 10% maximum from nominal 115 volts rms input, will cause corrective changes in the drop across Q1 for less than ± 3% change in the output. Capacitor C24 serves to average the DC current pulses through the transistor and bypass any AC ripple. C23 operates in the same manner for the base bias current. Taps are provided on the transformer T3 primary to compensate for voltage tolerance of the Zener diode.

2-9 HIGH VOLTAGE SUPPLY

When transformer T2 is energized by depressing the H. V. ON switch, approximately

4000 volts DC is supplied to the series control tubes, V1 V2 and V3 in parallel from the voltage doubling network of capacitors C4 and C5, rectifiers SR3 to 11, SR12 to 20 and winding 2-3 of T2.

The series regulating tubes V1, V2 and V3 in parallel are controlled by amplifier tubes V4 and V5 to provide an electronically regulated supply with a nominal value of 3500 volts. Reference voltage is developed across V6, V7 and V8 and is compared with the supply output voltage at the grids of differential amplifier V5. The amplified difference at the plates of V5 is applied to the cathode and grid of the left half of V4 by employing the right half of V4 as a cathode follower. The difference voltage is further amplified and appears at the plate of V4 left half as a single ended output to drive the grids of the series regulator tubes V1, V2 and V3. The series tubes will conduct more or less as required to reduce the difference in grid voltages to the differential amplifier V5 to zero and thereby maintain the supply output at -3500 volts.

The supply voltage is sampled by a resistor divider network consisting of HELIX CALIB. potentiometer R36 and precision resistors R37 through R44 to provide the input to grid (pin 2) of differential amplifier V5.

The positive side of the supply is connected to ground. The capsule and collector of the TW tube are connected to the ground side and the cathode to the -3500 volt side of the supply.

Helix voltage is obtained from the left half or pentode side of V9 acting as a cathode follower. The grid of V9 (pin 7) is connected to front panel control potentiometer marked HELIX and can be varied from approximately 0 to -500 volts with respect to ground or conversely from +3000 to +3500 volts with respect to TWT cathode. The plate voltage of V9 left half is supplied by T2 winding 4-5 through rectifier SR2B and filter capacitor C3. HELIX CALIB. potentiometer R36 provides compensation for component tolerance variations so that accurate calibration of HELIX control potentiometer can be made.

Helix current through R67 varies the bias on tube V9 right half. When the helix current reaches maximum safe value, the bias is increased sufficiently to cut off the tube and drop out overcurrent relay RY2. Contacts of RY2 open the H. V. circuit to remove all high voltages from the TWT electrodes. Voltage for the plate of V9 right half and RY2 in series is provided by T1 winding 3-4 through resistor R1, rectifier SR1 and filter capacitor C1.

Filaments of series tubes V1, V2 and V3 are connected in series so that failure of one will turn off all and prevent overloading of operative tubes. Heaters of amplifier tubes and overcurrent relay tube V9 are also connected in series so that open circuit on any heater will turn all off, dropping out relay RY2 and removing high voltage.

Anode voltage is obtained from the wiper of front panel potentiometer marked ANODE through the resistor divider string of R72 through R83. ANODE CALIB. potentiometer R72 provides compensation for component tolerance variations for calibrating the ANODE potentiometer R73. ANODE potentiometer R73 permits setting of TWT anode voltage to desired operating value.

Helix, Anode and Cathode tip jack connections are provided on the rear of the instrument for external voltage measurements.

Switch SW5 selects either Collector or Helix current to be measured with meter M1. Shunts

R84 and R85 provide scale multiplication. During the switching action of SW5 only the meter connections are broken, the shunts remain in their respective circuits so that neither the collector or helix circuits are broken during switching.

Filaments of V4, V5 and V9 are connected in series to provide fail safe operation by dropping out the H. V. relay in the event that either V4 or V5 should open.

2-10 EXTERNAL PULSE MOD AND GRID CALIB.

Transformer T3 winding 1-3, rectifiers SR27 and SR28, capacitors C25 and C26 form a voltage doubling network to provide -300 volts relative to the TWT cathode line. GRID CALIB. potentiometer R89 in series with R90 across the supply furnish a variable grid voltage of 0 to approximately -70 volts which is connected to the grid through EXT PULSE MOD switch SW4A and R91 when SW4A is in OFF position.

When the EXT PULSE MOD switch SW4 is in the ON position, the -300 volts is connected to the TWT grid through R91 to bias the TW tube to cutoff. An external positive pulse may now be applied to the TWT grid through EXT PULSE MOD connector S1, SW4B and capacitor C28 to grid modulate the tube. The amplitude of the pulse must exceed approximately 270 volts to turn the tube on. The TW tube in this amplifier is of the convergent flow type and GRID voltage affects focus. The transition from -300 volts to operating grid value must be made very rapidly, otherwise high helix current and hence trip out would occur. Diode V10 serves as a clamp during pulse operation to limit the grid voltage from exceeding the normal CW value as set by the GRID CALIB potentiometer R89. In the OFF position of SW4B the junction of C28 and R92 is connected to +280 volts to decrease the voltage change across C28 when EXT PULSE MOD switch is changed from ON to OFF position.

SECTION 3 - INSTALLATION AND OPERATION

3-1 INSTALLATION

Upon receipt carefully unpack and inspect the instrument for damage received from transit. Should any damage be found, follow procedure outlined on "Shipment Damage Claim" page at the end of this manual.

This instrument is designed for either bench or rack operation in normal ambient temperatures. Air flow through the unit and from the solenoid exhaust should be completely unrestricted. Operation in the presence of very strong magnetic fields should be avoided unless external magnetic shielding is provided. Primary power requirements are 105 to 125 volts, 50 to 60 CPS, approximately 1200 VA. If operation at other voltage or frequency is contemplated, consult manufacturer.

The 526, 527, 528 instruments are supplied with grey sheet metal sides containing handles. If the instruments are to be rack mounted, the screws on each handle side except those holding handle, should be taken out and the sides removed. Unit is now ready for inserting into rack. Supports should be provided in the rack to carry the weight of the unit upon its insertion or removal.

3-2 INITIAL OPERATION

1. Before turning on power, set panel controls:

   ANODE to MIN
   HELIX to 3000
   METER switch to HELIX
   EXT PULSE MOD to OFF

2. Turn on power and allow instrument to warm up at least 5 minutes.

3. Depress HIGH VOLTAGE ON switch.

4. Slowly advance HELIX control to operating value specified on TW tube data sheet. Note that as HELIX is advanced, helix current should be well below 3 ma. If helix current is near or exceeds 3 ma the TWT probably requires realignment in its solenoid. See Paragraph 4-6 for alignment procedure.

5. Slowly advance ANODE control to MAX. Before MAX position is reached helix current will peak and then drop down to an operating value well below 3 ma. Should helix current remain near or exceed 3 ma, the TWT will require realignment as noted above.

6. When ANODE has been advanced to MAX and HELIX to value specified on tube data sheet with helix current at or below its maximum value, change METER switch to COLLECTOR X20. Current should be at or slightly greater than the operating value of cathode current given on the TW tube data sheet enclosed at the rear of this manual. If current reading is too low, ANODE CALIB. control near top right side of chassis requires resetting. Remove top dust cover for access to control. Adjust until rated cathode current given on tube data sheet is obtained, alternately checking helix current to assure it remains below maximum value. If unable to obtain rated value with helix current below 3 ma, the TWT requires realignment.

7. Apply RF. Input power up to 1 watt will not cause damage. However, only the normally required level of a few milliwatts or less should be used. If RF output can be observed, adjust, if necessary, HELIX voltage slightly for optimum output. See also sub-section following, titled SYNCHRONISM. If RF output cannot be measured, connect a $\frac{1}{2}$% or better accuracy voltmeter to read HELIX VOLTAGE between HELIX and CATHODE tip jacks at rear of instrument and set HELIX control to give a measured voltage of exactly that specified on TW tube data sheet.

8. If significant line frequency is observed, very slight repositioning of the TW tube in the solenoid may be required to null out stray magnetic fields from the power transformers in the instrument. Both helix current and AC field nulls occur at essentially the same mechanical positions, so slight turning of the adjusting screws, usually will give best modulation minimum without appreciably affecting helix current. Be sure that adjusting screws are locked at the best position, and adjusting hole covers on solenoid are in proper place.

9. Resetting of ANODE control and a recheck of helix voltage, as described in 4 and 5 above, may be necessary after one hour to correct for slight warmup drift. Position of ANODE control on panel should be noted so that it can easily be reset, should it accidentally be changed.

10. METER switch should be left in COLLECTOR X20 position during normal operation. An occasional check of helix current is recommended.

3-3 SYNCHRONISM

When velocity of the electron stream and the progressive velocity of the RF signal are essentially the same, they are said to be in SYNCHRONISM. When operation at a single frequency is contemplated, helix voltage can be adjusted to synchronous value, to give maximum gain and output at that frequency. When operation over a wide band of frequencies is contemplated, the helix voltage adjustment should be made to the factory determined value. At this setting synchronism usually occurs at some frequency usually near the high end of the band. Even though other frequencies are off synchronism, rated broadband response results.

3-4 REPEAT OPERATION

1. Before turning on power, turn ANODE control to MIN.

2. Turn on power and allow 5 minutes warmup.

3. Depress HIGH VOLTAGE ON switch and raise ANODE to MAX., noting that helix current does not exceed 3 ma and should drop well below this at MAX position. If too high, turn ANODE to MIN and follow procedure outlined in INITIAL OPERATION Paragraph 3-2 above, to optimize performance.

3-5 OPERATION AS AN AMPLIFIER

Amplification is linear for RF output up to 6 db below saturation. Further drive beyond this level causes the output to flatten and then decrease. Operation in the region of saturated output is non-linear, causing appreciable distortion and harmonic content in the output signal.

3-6 OPERATION AS A BUFFER.

The Models 526, 527, 528 can serve very effectively to isolate a microwave signal source from a load. Reflections from mis-matches, load variations, and the effects of modulation will not appreciably affect the impedance of the input terminals of the amplifier. The attenuator on the TW tube helix provides approximately 55 db attenuation between input and output, so load changes will be isolated from the source by this 55 db attenuation less the gain of the amplifier. The extreme case of a short or open circuit would be to change the VSWR of the amplifier input by about 7%.

3-7 OPERATION AS AN OSCILLATOR

The use of an external feed-back circuit involving a passive resonator such as a cavity,

will permit use of the TW tube amplifier as an extremely stable fixed frequency or wide range oscillator. Oscillation results when total loop phase shift is in the vicinity of n x 360° producing positive feedback. This is accomplished by careful adjustment of helix voltage. Since helix voltage accelerates the electrons in the beam, it determines their velocity through the helix. Transit time and phase between output and input of the TW tube therefore, varies with helix voltage. When a continually adjustable resonator is employed, it is necessary to optimize phase with the HELIX control progressively across the band. Otherwise, a series of oscillation modes will occur as phase of the TW tube amplifier rotates. A directional coupler or non-dissipative attenuator should be employed in the feedback line to minimize amount of output power fed to the input. This reduces harmonics and makes available almost all output power to drive a load.

SECTION 4 - MAINTENANCE

4-1 GENERAL

CAUTION: Extremely dangerous high voltages exist in this instrument. Observe the utmost care when checking or making repairs.

Routine maintenance should consist of the following:

1. Check blower operation every three months or after 1000 hours use, and oil bearings with a few drops of light machine oil in the oil tubes provided. Regular attenuation to the blower is essential since its failure could result in damage to the TW tube from overheating.

2. Test at regular intervals the power supply tubes to detect marginal performance. Any voltage regulator tubes removed for test should be returned to their original sockets. INTERCHANGING OR REPLACING VOLTAGE REGULATOR TUBES WILL NECESSITATE RECALIBRATION OF HELIX SUPPLY VOLTAGE.

3. As TW tube ages, pre-set ANODE CALIB control may require re-adjustment to maintain rated collector current when panel ANODE control is at maximum.

4-2 CALIBRATION OF HELIX SUPPLY VOLTAGE

Calibration of helix supply voltage is accomplished by connecting an ungrounded voltmeter having ½% accuracy or better to the Helix Voltage test points on the rear of the unit. Unlock the HELIX CALIB control, located near the right top side of chassis. With TWT disconnected, move panel HELIX control over entire range and note readings. Adjust HELIX CALIB control so that voltage indications are within ± 2% for any setting. Lock HELIX CALIB control.

4-3 TROUBLE SHOOTING

Should a failure occur, follow a logical procedure to locate the cause. Refer, if necessary, to the THEORY OF OPERATION section and the schematic diagram included in this manual. Blown fuses should be replaced with 250 volts, type 3AG. Power supply tubes can be observed to determine if heaters are operating and voltage regulator tubes lit, by removing screws

holding top dust cover and sliding it rearward. Operating voltages for the traveling wave tube may be measured as described below. Correct voltages are indicated on the circuit diagram.

Helix: Helix and Anode voltages relative to cathode are available at tip jacks on rear cover. CAUTION: Use high resistance, ungrounded DC voltmeter, HIGH VOLTAGES EXIST ON TERMINALS.

The Grid and Heater voltages may most easily be checked by removing power from the instrument and disconnecting the TWT connectors from sockets S2 and S5. The electrode voltages are then accessible (power on) at the connector pins. Use a high resistance DC voltmeter insulated from ground in making measurements. Refer to schematic and check out sheet for correct values and polarity.

If tubes have been tested and found to be normal and supply voltages are incorrect, it is recommended that power be disconnected and faulty components located by a systematic resistance check.

For access to chassis components remove right handle side and cover side.

For access to solenoid chassis remove left handle side and cover plate.

For access to solenoid supply transistor located in air stream of blower, proceed as follows:

1. Remove screen, bottom plate, L. H. handle side and cover side.
2. Remove two #6-32 screws which are on L. H. transistor bracket (as viewed from front of unit), accessible through clearance holes in solenoid chassis.
3. Remove two #6-32 screws on R. H. bracket accessible from inside unit near blower.
4. Blower may now be removed.
5. Pull bracket holding transistor out from blower until transistor is accessible.
6. Use care in mounting anduse heat sinks when soldering connections to transistor.
7. Follow reverse procedure in reassembly.

For access to panel components remove top dust cover and/or bottom plate. For access to panel indicators and fuses, blower must be removed. (See above)

Components mounted in solenoid sub-chassis are accessible by removing four screws holding sub-chassis to solenoid chassis.

CAUTION: Use heat sinks during soldering operations on transistors and diodes.

4-4 BLOWER REPLACEMENT

Remove bottom plate and top dust screen, remove four mounting screws (6-32) as described in Paragraph 4-3.

Disconnect two transistor mounting brackets from blower housing.

Remove blower leads from barrier strip on solenoid chassis.

Blower may now be removed. In reassembly follow reverse procedure.

4-5 TRAVELING WAVE TUBE REPLACEMENT

1. Remove top dust screen.
2. Remove RF cover plate from front panel.
3. Remove TWT clamp from rear of tube.
4. Disconnect TWT lead connectors.
5. Loosen TWT adjusting hold covers for access to TWT locking screws.
6. Loosen TWT locking screws.
7. Tube is now free for removal through front panel.
8. Center new tube in solenoid and place TWT clamp to scribe line on shell. Observe due caution to prevent damaging the tube.
9. Make TWT lead connections, replace cover plate, etc.
10. Use care in making wave guide connections to avoid undue strain on the RF connectors. The tube is held in place in the instrument by the TWT adjusting screws. Excessive pressure on the connectors could result in misalignment or damage to the tube.

4-6 TRAVELING WAVE TUBE ALIGNMENT

Realignment of the TWT within the solenoid is necessary after TW tube replacement or where de-focus has occurred due to repair, shock or other reasons.

1. Before turning on power, set panel controls:

   ANODE at MIN
   HELIX at 3000
   METER switch to HELIX
   GRID CALIB. to fully CCW
   ANODE CALIB. to fully CCW

2. Turn on power and allow amplifier to warm up at least 5 minutes.

3. Alignment is accomplished by removing top perforated dust cover and adjusting the TW tube positioning screws at each end of the solenoid. Orient TW tube to obtain the lowest HELIX current, all the while advancing HELIX and ANODE controls. ADJUST CAREFULLY TO AVOID HIGH HELIX CURRENT DURING ADJUSTMENT. Should helix current accidentally exceed 3 ma, overcurrent relay will shut off power supply. Operation can be restored by turning ANODE control counterclockwise and then again depressing HIGH VOLTAGE ON switch. If helix overcurrent trip occurs again, turn EXT PULSE MOD switch to ON. This puts -300 volts on GRID so that a rough alignment can be made without trip out. After obtaining control of helix current in this position return EXT PULSE MOD to OFF for greater sensitivity before continuing with the alignment.

   Positioning of the TW tube is most easily accomplished with two screwdrivers in each end. Starting with the tube approximately in the center of the solenoid, slowly wobble the tube with the alignment screws to minimize helix current. Adjust alternately with the two top screws at each end. After a minimum setting is reached, one screw should be turned, usually causing helix current to increase, and then the null relocated by turning a different screw. Often the new null is lower than the original. Reverse direction of turning if the new null is higher. Slight rotation of the TW tube may also result in a lower minimum. With a little care, helix current usually can be reduced to a safe value. Locking screws on bottom should be tightened enough to prevent the tube shifting during normal handling of the instrument. Be sure to replace adjust hold cover to prevent air loss and overheating.

   Maximum helix current (under drive) up to about 3 ma is safe. However, the lower the current, the less chance that gas will be driven from the helix due to high temperature operation. Gas would soon damage the cathode emission and render the TW tube inoperative. Lower current also reduces modulation of the RF output by beam noise and stray magnetic fields.

4-7 TRAVELING WAVE TUBE WARRANTY

All workmanship and materials, except the traveling wave tube, are guaranteed for one year. Details concerning warranty adjustment are presented on "Shipment Damage Claim" page at the end of this manual.

The traveling wave tube is guaranteed for 500 hours use or one year, whichever occurs first. Cost of an in-warranty replacement traveling wave tube will be prorated accordingly. Warranty requests should include a description of the failure, factors leading to it, and an accurate estimate of operating hours.

MODELS 526, 527, 528
TWT SUPPLY CHECK
Model No. 526, Serial No. 32

GRID @ 115 V S5 Pin F to chassis, S2 Pin A shorted to chassis

EXT PULSE MOD off, H. V. off E min. (<1) volt
EXT PULSE MOD off, H. V. off E max. (>55) volts Ripple (<25) mv pk to pk
EXT PULSE MOD on, H. V. off E (>300) volts @ 103 V input Ripple (<1) volt pk to pk
EXT PULSE MOD on, H. V. off E (<6 volt change) from 103 volts to 127 volts input
Remove Jumper from Pin A to chassis.

HELIX S2 Pin C to Pin A

HELIX at 3000 volts, collector at 60 ma E min. (2940-3060) volts
Ripple (<300) mv pk to pk
HELIX at 3500 volts, collector at 60 ma E max. (3430-3570) volts
Ripple (<300) mv pk to pk

Helix control calibration within 2%
Overcurrent relay trips at (2.7 - 3.3) ma

COLLECTOR S2 Pin A to chassis (Pin A is Neg.)

Collector @ 60 ma E (3430 - 3570) volts E input min. (<103) volts

ANODE S2 Pin B to Pin A CAUTION: This must be done differentially since both pins are at high voltage.

No load, E max. (>3430) volts Ripple (<200) mv pk to pk
No load, ANODE CALIB. MIN., E max. (<2700) volts Ripple (<200) mv pk to pk
No load, E min. (<2000) volts

HEATER S2 Pin E to Pin A CAUTION: High Voltage

103 volts input E (6.0 - 6.6) volts AC at .4 amps.
E (< .6 volt change) from 103 volts to 127 volts input.

SOLENOID TS3-1

After 15 min. warmup:

I (5.2 amp) at 127 volts input
I (< .3 amp) change from 127 volts to 103 volts input Ripple (<1) volts pk to pk

TUBE DATA

Tube Type [illegible], Serial No. [illegible]

E Helix Sat. _____ V I Helix [illegible] ma @ _____ Gc I Collector _____ ma @ _____ Gc
SSG _____ V _____ ma @ _____ Gc _____ ma @ _____ Gc

SSG _____ @ _____ Gc Sat.G. _____ @ _____ Gc Max.Power _____ dbm @ _____ Gc
_____ @ _____ Gc _____ @ _____ Gc _____ dbm @ _____ Gc

SYM	DESCRIPTION	NO.	DATE	BY

HIGH VOLTAGE

POWER

ALL RES. 1W., 10% AND ALL CAPS. MFD., 600 V EXCEPT AS NOTED.

*METER M-1 IS A 1 MA MOVEMENT WITH 0-3 MA SCALE

MICROWAVE AMPLIFIER	
MODEL 526, 527, 528 14, 16, 17, 19 & UP	
TOL: FRAC. ±1/64 DEC. ±.005 ANGLE ±1/2° UNLESS INDICATED OTHERWISE	
ALFRED ELECTRONICS	
DRAWN S.K.B.	DATE 5-1-61
APPR'D R.F.H.	DWG. NO 900416D

MICROWAVE ELECTRONICS CORPORATION
4061 Transport Street
Palo Alto, California

TUBE WARRANTY

PLEASE READ IMMEDIATELY

Shipping Damage

Please examine the tube immediately upon receipt for physical damage. Also compare the electrical performance against the accompanying data sheet as a check for damage in shipment. Each tube is subjected to complete electrical and mechanical tests after manufacture and prior to shipment from the factory. Any damage due to shipping as evidenced in the above inspection is the responsibility of the carrier. Claims must be filed immediately upon receipt of the tube with the carrier if prompt adjustment is to be obtained from the carrier.

Warranty

This tube is warranted by Microwave Electronics Corporation to be free of manufacturing defects for 12 months from date of shipment from the Microwave Electronics Corporation factory. To qualify under the terms of this warranty, credit will be offered only if replacement claims are made in accordance with the Tube Return Procedure, if the tube was operated in accordance with the instructions which accompanied the tube, and if the enclosed warranty card is executed and on file with the manufacturer.

If the tube should fail during the specified warranty period because of a defect in manufacture, credit will be allowed as follows if the manufacturer is at fault:

August 1, 1961

1. Warranty Categories

In connection with heater operating time we have classified the tubes into categories as follows:

a. TW-1A for M2200 and M2300 series traveling-wave tubes.

b. TW-2A for M2100 series of traveling-wave tubes.

c. TW-3A for M2400 series of traveling-wave tubes.

d. TW-4A for M2500 and M2600 series of traveling-wave tubes.

e. For tubes in developmental category the warranty provisions which apply will be those specified in the basic contract.

f. For all other M series of tubes the warranty provisions which apply will be those specified in the basic contract.

2. Warranty TW-1A Low Power Output Traveling-Wave Tubes

a. Shelf-Life Warranty:

Microwave Electronics Corporation warrants its tubes unconditionally for a shelf-life period of 12 months from date of shipment. If the tubes should fail when placed in operation after having been stored up to 12 months from date of shipment, 100% credit will be allowed on a replacement tube.

b. Microwave Electronics Corporation warrants its tubes unconditionally during the first 500 hours of heater operating time or 12 months from date of shipment, whichever is less, and/or a pro rata basis for total heater operating time up to 2,000 hours, or up to 12 months from date of shipment, whichever is less. If the tube should fail at any time during the first 500 hours of heater operating time, and within 12 months from date of shipment, 100% credit will be allowed on a replacement tube. If the tube should fail after operating for 500 hours and up to 2,000 hours or 12 months from date of shipment, whichever is less, pro rata credit will be allowed. For example, if the tube should fail after operating 1,600 hours and 9 months after date of shipment, the credits would be respectively, 20% (400/2000ths) and 25% (3/12ths), and the lesser credit of 20% would be allowed on a replacement tube.

3. Warranty TW-2A Low Noise, Low Power Output Traveling-Wave Tubes

a. Shelf-Life Warranty:

Microwave Electronics Corporation warrants its tubes unconditionally for a shelf-life period of 12 months from date of shipment. If the tubes should fail when placed in operation after having been stored up to 12 months from date of shipment, 100% credit will be allowed on a replacement tube.

b. Microwave Electronics Corporation warrants its tubes unconditionally during the first 500 hours of heater operating time or 12 months from date of shipment, whichever is less, and/or a pro rata basis for total heater operating time up to 1,500 hours,

or up to 12 months from date of shipment, whichever is less. If the tube should fail at any time during the first 500 hours of heater operating time and within 12 months from date of shipment, 100% credit will be allowed on a replacement tube. If the tube should fail after operating for 500 hours and up to 1,500 hours, or 12 months from date of shipment, whichever is less, pro rata credit will be allowed. Calculation of credit would be made in the manner shown in the example in description under warranty TW-1A.

4. Warranty TW-3A Medium Power Output Traveling-Wave Tubes

a. Shelf-Life Warranty:

Microwave Electronics Corporation warrants its tubes unconditionally for a shelf-life period of 12 months from date of shipment. If the tubes should fail when placed in operation after having been stored up to 12 months from date of shipment, 100% credit will be allowed on a replacement tube.

b. Microwave Electronics Corporation warrants its tubes unconditionally during the first 500 hours of heater operating time or 12 months from date of shipment, whichever is less, and/or a pro rata basis for total heater operating time up to 1,000 hours, or up to 12 months from date of shipment, whichever is less. If the tube should fail at any time during the first 500 hours of heater operating time and within 12 months from date of shipment 100% credit will be allowed on a replacement tube. If the tube should fail after operating for 500 hours and up to 1,000 hours, or 12 months from date of shipment, whichever is less, pro rata credit will be allowed. Calculation of credit would be made in the manner shown in the example in description under warranty TW-1A.

5. Warranty TW-4A High Power Output Traveling-Wave Tubes

a. Shelf-Life Warranty:

Microwave Electronics Corporation warrants its tubes unconditionally for a shelf-life period of 12 months from date of shipment. If the tubes should fail when placed in operation after having been stored up to 12 months from date of shipment, 100% credit will be allowed on a replacement tube.

b. Microwave Electronics Corporation warrants its tubes unconditionally during the first 250 hours of heater operating time or 12 months from date of shipment, whichever is less, and/or a pro rata basis for total heater operating time up to 500 hours, or up to 12 months from date of shipment, whichever is less. If the tube should fail at any time during the first 250 hours of heater operating time and within 12 months from date of shipment, 100% credit will be allowed on a replacement tube. If the tube should fail after operating for 250 hours and up to 500 hours, or 12 months from date of shipment, whichever is less, pro rata credit will be allowed. Calculation of credit would be made in the manner shown in the example in description under warranty TW-1A.

6. Specification Tolerances

During the unconditional heater operating time portion of the above referenced warranties, Microwave Electronics Corporation guarantees the tubes will unconditionally meet the specifications for the specific tube type involved as listed in the basic approved specifications for that type. Once the tube has exceeded the unconditional heater operating time warranty period under the applicable warranty for that tube type, the following tolerances will apply before the tube is considered out of warranty:

a. Power output -1½ db

b. Gain -2 db

c. Noise figure +2 db

7. Special Conditions

a. If the tube should fail when operated within any warranty period, the manufacturer retains the right to repair such tube to make it operational, without granting a second new tube warranty or credit on a replacement. For example, if a tube is placed in operation after having been stored for four (4) months and fails after being operated for 50 hours due to a short between pins in the dc plug, Microwave Electronics will repair such defect and return the tube to the purchaser.

b. Microwave Electronics does not recommend that tubes be taken "off the shelf" and operated on a periodic basis to prevent deterioration in storage and to qualify for warranty coverage. Tubes which have been stored for a long period of time should be operated at specified heater and dc voltages for one hour after storage before measurements for compliance with specification are made. For "burn in" procedure refer to the specification sheet for the respective tube type.

c. The final determination, after proper evaluation, as to whether the tube failed in normal operation thereby bringing it under the applicable warranty, or whether the tube was misused thereby excluding it from application of the warranty provisions, lies with Microwave Electronics Corporation after due consideration of all of the facts relating to the failure.

d. Capsule Credit; After Warranty Period Has Expired:

Regardless of shipping date and/or heater operating time, a credit of 10% of the original purchase price or a $100 allowance , whichever is less, will be applied to the purchase price of a replacement tube. However, no capsule credit will be allowed for a returned tube if the capsule seals have been disturbed or the tube has been tampered with.

8. Warranty Card

Immediately upon receipt of a Microwave Electronics Corporation Tube, the user of the tube should complete and submit the enclosed warranty card. As noted above, execution of the warranty card is a condition for making credit allowances in the event of tube failure.

9. Tube Return Procedure

In order to expedite the return of a tube and the granting of credit allowances, please determine that the tube is at fault prior to starting return procedures. If possible, verify such determinations by substituting with a spare tube. It is requested that Microwave Electronics Corporation's Representative in your area be notified of the failure to permit his examination of the failure, and to expedite the arrangements for application engineering assistance at the customer site, or the approval for return of the tube to Microwave Electronics Corporation for evaluation and repair, or replacement, as the circumstances dictate.

a. Complete the Tube Service Report. Please be sure that all data is entered as noted on the form and describe fully what happened when the tube failure occurred.

b. Submit the Tube Service Report to Microwave Electronics Corporation together with a request that authorization be given for the tube to be returned. If Microwave Electronics Corporation determines that the tube should be returned after reviewing the Tube Service Report, notification to return the tube will be made. In no event will Microwave Electronics Corporation accept return shipments without first having given its prior written approval.

c. If notification is given by Microwave Electronics Corporation to return the tube, repack the tube as originally packed at time of shipment, if at all possible.

d. Ship the tube prepaid on a memo billing basis. Do not issue debit memos until advised by Microwave Electronics Corporation.

e. If examination and testing of the tube indicates that the tube is serviceable and/or that failure was not the fault of the manufacturer, the tube will be repaired and returned to the customer at the customer's expense.

f. If Microwave Electronics Corporation finds that a replacement tube is in order, the customer will be notified of such a determination. A new tube will be shipped immediately upon receipt of the customer's written authorization to ship the replacement. At the time the customer is notified that a replacement will be made, the customer will also be advised of the cost of the replacement tube and the amount of credit which will be allowed for the failure of the original tube.

g. If a returned tube proves not to be defective after test and evaluation at the Microwave Electronics Corporation plant, a charge of $50.00 will be invoiced to the customer involved to cover the required testing and handling costs incurred.

10. Total Warranty Period

The warranty period in all respects under this warranty contract expires 12 months from date of shipment of the tube involved from the Microwave Electronics Corporation factory unless provided otherwise in the basic contract under which the tube was procured.

MICROWAVE ELECTRONICS CORPORATION
4061 Transport Street
Palo Alto, California

TUBE SERVICE REPORT

pe Type_____ Serial Number_____
ndition upon Receipt_____
te Received_____ Date Placed in Service_____
te First Tested_____ Date of Failure_____
al Hours of Heater Operation_____

tement of Operating Conditions at Time of Failure:_____

re there other circuit component failures at time of tube failure?_____

thod of cooling used?_____
at helix overcurrent protection was provided?_____

enoid Type_____ Voltage_____ Current_____
enoid Temperature_____ Ambient Temperature_____

OPERATING CONDITIONS

	Upon Installation	Just Prior to Failure
ater Voltage - volts		
ater Current - amps		
de Voltage - volts		
de Current - amps		
ix Voltage - volts		
ix Current - ma		
lector Voltage - volts		
hode Current - ma		
imum S-S Gain - db		
imum Saturation Power Output - dbm		
imum Noise Figure (low noise tube only) - db		

ner's Name_____ Authorized Signer_____
ress_____ Signature
e_____ Title_____

SHIPMENT DAMAGE CLAIM

The instrument should be tested as soon as it is received. If it fails to operate properly or is damaged in any way, a claim must be filed with the carrier. Have carrier agent inspect damage to instrument and packing crate and forward to us a copy of his written report. You will then be advised of replacement or repair arrangements and disposition of the equipment. Please include model number, type number and serial number when referring to this instrument for any reason.

WARRANTY

ALFRED ELECTRONICS warrants each instrument manufactured by them to be free from defects in material and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory for that purpose and the replacing of any defective parts. This warranty is effective for one year after delivery to the original purchaser; when the instrument is returned, transportation charges prepaid by the original purchaser, and which upon our examination is disclosed to our satisfaction to be defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at cost. In this case an estimate will be submitted before the work is started.

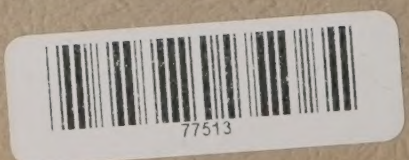
If any fault develops:

1. Notify us, giving full details of the difficulty, including the model number, type number and serial number. Upon receipt of this information you will be sent service instructions or shipping data.

2. Upon receipt of shipping instructions forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins when instrument is not covered by this warranty.

PACKING

The instrument should be packed in the original carton. If unusable or not available, use a wooden box with approximately three inches of excelsior or other shock-absorbing material surrounding the instrument. If desired, packing services of a local Transfer and Storage company may be employed.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